**Association of Children’s Hospital Status on Value for Common Surgical Conditions**

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**ABSTRACT**

**Importance:** Children’s hospitals (CH) provide a significant proportion of pediatric care in the United States. It is known that CH provide more specialized care than non-children’s hospitals (NCH), but the value of CH for routine surgical procedures is unknown.

**Objective:** To determine the value of CH for routine surgical procedures by assessing clinical outcomes and payment data.

**Design, Setting, and Participants:** This was a retrospective cohort study of pediatric patients undergoing one of 13 commonly performed surgical procedures between 2010 and 2015 using administrative data from the Health Care Cost Institute (HCCI).

**Exposure:** The primary exposure was tier of CH status, defined using self-reported pediatric services, affiliation with pediatric focused programs, and validated based on proportion of pediatric admissions.

**Main Outcomes and Measures:** Payments for common surgical procedures from private insurers and overall complication and readmission rates at 30, 60, and 90 days.

**Results:** There were 22,878,211 pediatric HCCI claims from 2010-2015 with 368,220 representing the surgical procedures of interest. 118,977 had their procedure at freestanding CH (CH-A), 75,256 at CH attached to an adult hospital (CH-B), and 173,987 at NCH. The average payment for all procedures at CH-A was $6,533.56, at CH-B $5,847.50, and at NCH $5,034.25. The overall complication rate was 0.004±0.06 at CH-A, 0.01±0.07 at CH-B, and 0.003±0.06 at NCH. Readmission rates at 30, 60, and 90 days were the same at all hospitals. After adjusting for zip code, year, surgery, surgery setting, and observable patient, hospital, and county characteristics, we estimate that payments for inpatient common procedures were 39% higher at CH-A than at NCH and 2% lower at CH-B than NCH. Payments for outpatient common procedures were 34% higher at CH-A than at NCH and 3% higher at CH-B than NCH.

**Conclusions and Relevance:** For children undergoing commonly performed surgical procedures, clinical outcomes are equivalent at CH and NCH but are associated with higher payments and, thus, overall lower value care. Payment adjustments at CH for commonly performed procedures may be warranted to ensure delivery of optimal value to patients and payers.

**INTRODUCTION**

Though children’s hospitals (CH) comprise less than 5% of all hospitals in the United States, CH account for 40% of pediatric inpatient days and 50% of costs for pediatric care.1 CH often provide high volume, specialized, and resource-intensive care to children who require highly trained care providers and innovative technologies. One such example is surgery for congenital heart disease where mortality rates are lowest at high-volume, specialized centers such as CH.2,3 For this type of highly specialized pediatric care, the value proposition of higher costs at CH is justified by demonstrable improved outcomes and quality.4 In 2009, 40 freestanding CH accounted for greater than $10 billion of annual U.S. healthcare expenditure, and the top 10 CH profited over $800 million.5 Contemporary pediatric care has also witnessed significant regionalization in the last decade, and there are currently several efforts underway to centralize the delivery of children’s surgical care to specialized centers.6–9 These trends represent a dramatic change in hospital market structure with regard to pediatric care.

Although CH have been shown to provide higher quality than non-children’s hospitals (NCH) for highly specialized procedures, there are compelling data to suggest that the cost of common and routine procedures, not just highly specialized care, is greater at CH than at NCH.10,11 Despite surgical interventions representing a high risk and costly experiences in our healthcare system, very little attention has been directed at surgeons, surgical care or surgical payment reform, transparency of surgical outcomes, and consumer/patient empowerment in choices surrounding surgical care.12,13 Of the 50 most prevalent and costly pediatric inpatient conditions, 32 are surgical conditions.14 Furthermore, surgical care accounts for a high proportion of overall healthcare spending.15 The financial and clinical implications of trends and policies related to the surgical care of children have not been fully evaluated and may result in a significant rise in health care costs without demonstrable improvement in quality.6,16

The primary objective of this study was to determine the value of CH for routine surgical procedures by assessing clinical outcomes and payments data. We compared the quality, by assessing complication and readmission rates, and price, using payment data, of commonly performed surgeries at CH and NCH. We then explored the extent to which quality and price differences could be explained by patient and hospital characteristics versus other economic factors such as hospital and insurer market structure.

**METHODS**

**Study Design and Data Source**

This investigation was a retrospectivecohort study using data from the Health Care Cost Institute (HCCI). The HCCI provides de-identified administrative cost and utilization data for over 10 million beneficiaries in the United States covered by private insurance and is ideal for evaluating variation in hospital-level pricing and payment. These data consist of the population of claims submitted to HCCI by Aetna, Humana, Kaiser Permanente, and UnitedHealthcare.17 HCCI data are representative of the national population younger than 65 using population weights based on U.S. Census Bureau data. We focus specifically on the pediatric population, where the HCCI data purportedly cover roughly 25% of all claims for privately insured children in the U.S.18 HCCI data have previously been used to evaluate variations in prices between states and Metropolitan Statistical Areas (MSA).19 The Ann and Robert H. Lurie Children’s Hospital of Chicago’s institutional review board deemed this study exempt from review. A waiver of informed consent was granted because the study was determined to be minimal risk and because data are deidentified.

**Study Cohort**

We analyzed claims data from 2010 to 2015 from HCCI.1719 From this population of privately insured beneficiaries, we selected a cohort of patients 18 years of age or less, who underwent commonly performed pediatric surgical procedures. We examined outcomes and costs following 13 common pediatric surgical procedures: anterior cruciate ligament (ACL) reconstruction, anti-reflux surgery, appendectomy, humerus fracture repair, tympanostomy tube placement, tonsillectomy and adenoidectomy, strabismus surgery, posterior spinal fusion, cholecystectomy, umbilical hernia repair, inguinal hernia repair, orchiopexy, and circumcision. Patients who underwent multiple procedures at the same visit (e.g., both tonsillectomy and tympanostomy) were included and classified as concurrent procedures. Final procedure inclusion was determined through a combination of literature review and clinical judgement to purposefully capture inpatient and outpatient populations as well as to represent the full spectrum of children’s surgical procedures performed at most hospitals.14 Procedures were identified with Current Procedural Terminology (CPT) and International Classification of Diseases, Ninth Revision (ICD-9) procedure codes using both facility and professional claims (Supplemental Table 1). We excluded newborns, patients who were transferred, and outliers, defined as payments below the 5th or above the 95th percentile of payment ratios.

**Hospital Classification**

CH were distinguished from NCH using a previously described methodology.20 In brief, hospitals were categorized using a combination of self-reported pediatric services on the American Hospital Association (AHA) Survey followed by validation using publicly available data on hospital membership in various pediatric programs such as the Children’s Hospital Association, Children’s Oncology Group, and American College of Surgeons National Surgical Quality Improvement Program-Pediatric. Using this methodology, three tiers of hospitals were created. A final validation used Health Care Cost Institute claims data to determine the proportion of pediatric admissions at each hospital.

**Outcome Measures**

Postoperative outcomes were identified using ICD-9 codes using both facility and professional claims for wound complications, surgical site infections, urinary tract infections, renal insufficiency, pneumonia, respiratory failure, sepsis, deep vein thromboses, pulmonary embolism, cardiac complications, intraoperative complications, and 30-day, 60-day, and 90-day readmissions (Supplemental Table 2). Negotiated payment rates and patient characteristics for each procedure were obtained from the HCCI database.

**Statistical Analysis**

Our statistical analysis proceeds in two steps. First, we test for differences in unadjusted mean payments and quality outcomes by hospital type (CH vs NCH). For a test of differences in complications, we employ the chi squared test; and for a test of differences in prices, we use the t-test as well as the non-parametric Kruskal-Wallis test.

Second, we examine differences in payments and quality in a regression context, in which we condition on observable patient variables (gender and co-morbidities), procedure type, and hospital characteristics. We employ linear regression models with market, year, and procedure fixed effects to examine differences in mean prices and complication rates conditional on covariates. More formally, we estimate by ordinary least squares (OLS) the following regression model:

where denotes the outcome (log price, 90-day readmission, or 90-day complication) for patient i with insurance product g at hospital h, market m, and year/month t; denotes patient and procedure characteristics including an indicator for the procedure, an indicator for whether the patient has any complex chronic conditions, an indicator for the inpatient vs outpatient setting, and an indicator for whether the patient is female; denotes hospital characteristics from the AHA survey data, including bed size, number of nurse, physician, resident, and other full time equivalents, total hospital discharges, total hospital Medicare discharges, and total hospital Medicaid discharges; denotes market-level variables from the American Community Survey, including percentage of residents of different age categories, race, income, and education; CH denotes an indicator for whether the hospital is a children's hospital; and capture fixed effects for the patient's insurance product (the insurance group ID) and year/month fixed effects; and is an error term. Standard errors are robust to heteroskedasticity and clustering at the hospital level.

The regression specification includes a set of indicator variables for the care setting (inpatient vs outpatient) and the specific procedure; however, these indicator variables likely do not fully capture important differences between CH and NCH. Therefore, in addition to an overall analysis of all procedures and all settings, we estimate this regression separately for each procedure and separately for the inpatient and outpatient settings. There are 26 such regressions in all, but not all results are available for these individual analyses due to small sample sizes.

All HCCI data were accessed remotely via Citrix Workspace. The claims data are stored in a Vertica database, from which an analytic dataset was created and managed using SAS version 9.4 (SAS Institute Inc, Cary, NC). All statistical analyses were performed using Stata version 15 (StataCorp) and R (the R Project for Statistical Computing).

**RESULTS**

**Patient and Hospital Characteristics**

Of the 67,939,211 patients represented in HCCI data spanning from January 1, 2010 to December 31, 2015, 22,878,572 (33.7%) were 18 years or less. Of these patients, 368,220 (1.6%) were identified to have undergone one of the index surgical procedures of interest. This cohort of patients was assigned to CH, subdivided into Tier A (CH-A) (freestanding children’s hospital) or Tier B (CH-B) (children’s hospital attached to adult hospital), or NCH. There were 118,977 (32.3%) patients in CH-A, 75,256 (20.4%) patients in CH-B, and 173,987 (47.3%) patients in NCH who underwent one of the index surgical procedures. (Figure 1).

The 368,220 patients included in this analysis were seen across 12,669 hospitals. 280 (2.2%) were Tier A Children’s Hospitals, 1,079 (8.5%) were Tier B Children’s Hospitals, and 11,310 (89.3%) were Non-Children’s Hospitals. 61% of the patients were male at CH-A, 63% at CH-B, and 58% at NCH. The average number of beds at CH-A was 263, CH-B was 647, and NCH was 210. 98% of CH-A were nonprofit hospitals whereas 72% of CH-B and NCH were nonprofit. Teaching institutions made up 36% of CH-A, 56% of CH-B, and 6% of NCH (Table 1).

**Surgical Procedures**

A variety of surgical procedures across multiple pediatric surgical subspecialties were evaluated. Tonsillectomy and adenoidectomy was the most common procedure performed with 104,163 cases, 27.5% were performed at CH-A, 17.6% at CH-B, and 54.9% at NCH. Cholecystectomy was the least common procedure with 426 cases, 17.8% were performed at CH-A, 20.4% at CH-B, and 61.7% at NCH. There were 45,565 patients who had concurrent procedures done under the same anesthetic, 31.5% at CH-A, 20.4% at CH-B, and 48.1% at NCH. (Table 1)

**Payments**

The mean payment from commercial insurers for all procedures evaluated was $6,553.56 (SD $6,399.97) at CH-A, $5,847.50 (SD $4,947.47) at CH-B, and $5,034.25 (SD $4,787.07) at NCH. Appendectomy for acute appendicitis had the largest difference in payments with CH-A receiving $5,618.75 more in payment than NCH. Posterior spinal fusion for scoliosis was the only procedure where NCH received higher payments than CH, with NCH receiving $406.50 more than CH-A and $1,947.06 more than CH-B (Figure 2).

**Complications**

There was no significant difference in the rate of surgical complications or readmissions within 30, 60, or 90 days of surgery at any of the hospital types. The overall complication rate was 0.004±0.06 at CH-A, 0.01±0.07 at CH-B, and 0.003±0.06 at NCH. Readmission rates at 30, 60, and 90 days were the same at all hospitals (Table 2).

**Log Negotiated Hospital Payments**

After adjusting for zip code, year, month, surgery, surgery setting, and observable patient, hospital, and county characteristics, we estimated that payments for inpatient common procedures were 39% higher at CH-A than at NCH and 2% lower at CH-B than NCH. Payments for outpatient common procedures were 34% higher at CH-A than at NCH and 3% higher at CH-B than NCH. Inpatient and outpatient appendectomy, humerus fracture repair, and tonsillectomy payments were higher at CH-A than NCH. Inpatient appendectomy, humerus fracture repair, and tonsillectomy payments were lower at CH-B than NCH. Outpatient appendectomy, humerus fracture repair, and tonsillectomy payments were higher at CH-B than NCH (Table 3).

**DISCUSSION**

There is an increasing desire on the part of consumers to understand the value proposition for rising healthcare expenditures in terms of clinical outcomes and costs.13 Value-based purchasing strategies for employer health plans have been discussed for over a decade but have been slow in adoption.21,22 The slow adoption surrounds poor definitions of value both in terms of outcome and costs. Our study demonstrates that for commonly performed pediatric procedures, CH have comparable clinical outcomes, higher costs based on actual payment data, and, thus, lower value compared to NCH. To our knowledge, no prior studies have examined the value of CH for commonly performed procedures using payment data.

Prior studies attempting to assess value rely upon costs estimated using hospital-level charges rather than actual payments.23,24 Hospital charges are problematic because they rely upon inflated figures that are typically several times actual costs. Further, charge-to-cost conversion ratios are hospital-specific and preclude reliable hospital comparison. In contrast, we utilized payments from private insurance carriers which are superior to charges and estimated costs as payments are a direct measure of prices paid for care. Payment data provide a better measure of the costs of care from a patient and societal perspective. To date, a barrier to this kind of work using payments is that valid payment information has been nearly impossible to obtain directly from the source as financial transparency is lacking. Using a novel approach made possible by access to the HCCI dataset of hospital payments, our proposed research is the first to examine actual payments across CH and NCH from four of the nation’s largest insurers.

Another challenge to assess value is that outcomes for common procedures are favorable with low rates of complications. Our study found there was no significant difference in the rate of surgical complications or readmissions within 30, 60, or 90 days of surgery at any of the hospital types, and the rate of complications and readmissions was exceedingly rare. It has been shown that clinical data is better than claims data when assessing complication rates, however, for these routine, commonly performed procedures with rare complication event rates, we expect that claims data would be reliable. Additionally, we evaluated readmission rates which are a reliable outcome metric regardless of if claims or clinical data are utilized.25 Readmission rates have also been shown to be higher for medically complex patients (REF). Our study demonstrated that for these procedures of interest readmission rates were similar regardless of CH status. This suggests similar comorbidity profiles and severity of illness between CH and NCH. The selection of the index procedures evaluated in our study was intentional to be representative of procedures that could be considered inpatient as well as outpatient. Further, we sampled procedures from a wide variety of children’s surgical subspecialities encompassing the full spectrum of children’s surgical care including general surgery, otolaryngology, orthopedic surgery, urology, ophthalmology, and neurosurgery.

Variation exists in how hospitals are defined as CH. We used a previously described rigorous method to classify hospitals as either CH or NCH based on American Hospital Association (AHA) survey results, publicly available data, and proportion of pediatric discharges based on HCCI data to validate the classifications.20 Multiple publicly available data points were used for validation, some of which were membership in the Children’s Hospital Association, Children’s Oncology Group, and pediatric trauma center designation. Multiple sensitivity analyses were performed to compare CH-A to CH-B to NCH, etc. and we found consistent results.20

Finally, CH may receive higher payments than NCH on routine surgical procedures not because the procedures cost more, but because of the higher cost and lower reimbursements associated with pediatric populations. NCH may be able to spread care delivery costs across larger cohorts or patients including adult populations who may have higher reimbursement.26 Further, CH care for a disproportionate number of uninsured or publicly insured patients compared to NCH.27,28 Last, CH are typically smaller with fewer beds and lower overall volumes compared to NCH leading to higher equipment and supply costs. While these trends may justify higher payments to CH for delivery of similar care as NCH, evaluation from the patient/consumer perspective demonstrates lower individual value at CH.

**Limitations**

This study has several limitations. First, HCCI data reflect payments and care delivery for employer based/privately insured patient populations. Depending on the specific state, Medicaid (including Medical Assistance, Children's Health Insurance Plan (CHIP) or any kind of government-assistance plan coverage) ranges from 17% (Utah) to 56% (New Mexico).29 Our results may not be generalizable to these publicly insured populations. Nevertheless, the large sample sizes included in our study and variable private insurance plans (with high and low deductible plans included) may increase the generalizability of our findings. Second, although these analyses clustered CH categories, we were unable to account for specific payments or outcomes based on nuances such as surgeon specialization or on geographical location of CH and NCH. This may lead to unmeasured differences in patient characteristics across the hospital-types assessed. Third, we did not evaluate referral practices and patient/family preferences toward undergoing surgical care at CH as compared to NCH. There may be a premium that patients and families are willing to pay to undergo care at CH. These preferential premiums assume that patients and families have freedom to select the definitive treating facilities and may be limited by insurer or policy factors. Last, using data from 2010 to 2015 may be criticized as dated. These analyses were conducted using the most contemporary data available at the initiation of this multiyear project and required extramural funding. As noted, payment data of this scope are rare, and this study represents one of the first of its type. With healthcare spending rising and pediatric care increasingly concentrated among specialized CH, our estimates may underestimate present-day payments.

**CONCLUSIONS**

For commonly performed surgical procedures in children, clinical outcomes are equivalent at CH and NCH but are associated with higher payments and, thus, lower overall value care. These results may not reflect all aspects of healthcare delivery that may define value for an individual patient and there may be a premium for which patients/families and insurers are willing to pay for access to highly specialized CH. Nevertheless, with increasing focus on value-based care, further research is needed to evaluate mechanisms to decrease costs and improve value at both CH and NCH alike.

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Figure 1

Table 1: Characteristics of patients undergoing surgery at children’s hospitals and non-children’s hospitals

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Total | Children's Hospitals (CH) | | Non-Children's Hospitals (NCH) |
| Characteristics |  | Tier A | Tier B |  |
| Hospitals | 12,669 | 280 | 1,079 | 11,310 |
| Patients | 368,220 | 118,977 | 75,256 | 173,987 |
| Patient-Level Characteristics |  |  |  |  |
| Female | 147,321 | 46,401 (39%) | 27,845 (37%) | 73,075 (42%) |
| Male | 220,899 | 72,576 (61%) | 47,411 (63%) | 100,912 (58%) |
| Hospital-Level Characteristics |  |  |  |  |
| Bed Size (mean) | --- | 263 | 647 | 210 |
| Nonprofit (mean) | 9,194 (72.6%) | 274 (98%) | 777 (72%) | 8,143 (72%) |
| Teaching (mean) | 1,384 (10.9%) | 101 (36%) | 604 (56%) | 679 (6%) |
| Procedures |  |  |  |  |
| Strabismus Surgery | 13,615 | 6,339 | 3,232 | 4,044 |
| Tympanostomy Tube Placement | 99,254 | 33,614 | 15,108 | 50,532 |
| Tonsillectomy and Adenoidectomy | 104,163 | 28,640 | 18,302 | 57,221 |
| Repair of Humerus Fracture | 14,719 | 5,480 | 3,749 | 5,490 |
| ACL Reconstruction | 736 | 123 | 107 | 506 |
| Posterior Spinal Fusion for Scoliosis | 4,384 | 2,027 | 1,282 | 1,075 |
| Anti-Reflux Surgery | 876 | 312 | 387 | 177 |
| Cholecystectomy | 426 | 76 | 87 | 263 |
| Appendectomy for Acute Appendicitis | 35,471 | 8,906 | 8,303 | 18,262 |
| Umbilical Hernia Repair | 8,241 | 3,535 | 2,682 | 2,024 |
| Inguinal Hernia Repair, Nonobstructive | 16,273 | 6,503 | 5,261 | 4,509 |
| Orchiopexy for Undescended Testicles | 7,831 | 3,199 | 2,605 | 2,027 |
| Circumcision | 16,666 | 5,864 | 4,857 | 5,945 |
| Concurrent Procedures | 45,565 | 14,359 | 9,294 | 21,912 |

Figure 2: Payments for common procedures

Table 2: Rate of surgical complications and readmissions

Table 3: Log negotiated hospital payment by commercial insurers after adjusting for zip code, year, surgery setting, and observable hospital and county controls. \*Signifies significance with p<0.01

Supplemental Table 1: Procedures included in the analysis were identified by CPT and ICD-9 codes.



Supplemental Table 2: Complications used to evaluate post-operative outcomes were identified using ICD-9 codes. For brevity, the \* represents all fourth or fifth digits that could designate an ICD-9-CM code. For example, 4151\* = 41511, 41512, and 41519.

